PATENT SPECIFICATION

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1 418 730

(54) ABRASIVE TOOL

(71) We, ORDENA TRUDOVOGO KRASNOGO ZNAMENI INSTITUT SVERKHTVERDYKH MATERIALOV AKADEMII NAUK UKRAINSKOI SSR, of 2 ulitsa Avtozavodskaya, Kiev, Union of Soviet Socialist Republics (U.S.S.R.), a state enterprise organised and existing under the laws of the U.S.S.R., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to abrasive tools, particularly but not exclusively to grinding wheels for machining hard-alloy and steel workpieces, and to hard-alloy-tipped cutting tools.

There have previously been proposed abrasive tools whose cutting layer incorporates clusters of diamond particles united by borosilicate glass, and a bonding material in which said diamond clusters are distributed (cf. US Patent No. 2,216,728).

According to the present invention there is provided an abrasive tool whose cutting layer comprises a bonding material throughout which are distributed diamond particles dispersed in glass, the glass comprising SiO_2, B_2O_3, an oxide selected from Na_2O and Li_2O, and an oxide selected from CaO, BaO, BeO, SrO and MgO, and the marginal angle of wetting of the diamond with the glass at a temperature in the range from 600 to 900°C being less than 90°.

Preferably the glass has the following weight percentage composition:

SiO_2	48—65
B_2O_3	20—3,
Na_2O and/or Li_2O	22—10,
an oxide or oxides selected from MgO, CaO, Beo, BaO, SrO	10—4
an oxide or oxides selected from TiO_2, Al_2O_3 ZrO_2, Cr_2O_3	0—18.

Especially good results are obtained when the glass comprises the following components (in wt.%):

SiO_2	48—65
B_2O_3	20—3
Na_2O	22—10
CaO	10—4
TiO_2	0—18.

Best results can be obtained when the components are taken in the following amounts (in wt.%):

SiO_2	55
B_2O_3	10
Na_2O	20
CaO	5
TiO_2	10.

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings, wherein:

Fig. 1 is a schematic view of a grinding wheel and a cutting layer thereof; and

Fig. 2 shows part of the cutting layer incorporating diamond particles aggregated into clusters by glass, in a tool of the present invention.

The present embodiment of the abrasive tool of this invention, made as a grinding wheel, has a cutting layer 1 (Fig. 1) which incorporates diamonds 3 (Fig. 2) dispersed in glass 4 to form clusters 2. The clusters 2 are distributed throughout bonding material 5.

The abrasive tool of this embodiment is manufactured as follows:

First clusters 2 are made, comprising diamond particles 3 united by glass 4. The glass 4 comprises SiO_2, B_2O_3, Na_2O, CaO and TiO_2, and the finished glass is disintegrated to obtain finely divided particles sized from 40 to 100 microns each.

Then the powdered glass is mixed with diamond particles of the required grain size, taken with the following ratios therebetween: with diamond powder having a grain size of from 400/315 to 100/80, 1 part by weight of the glass is taken per 2 parts by weight of the diamond powder; with diamond powder having a grain size of from 80/63 to 50/40,

1 part by weight of the glass per 1 part by weight of the diamond powder; with diamond powder having a grain size under 50/40, 1 part by weight of the glass per 0.5 part by weight of the diamond powder.

The thus-prepared mixture is placed in a crucible and heated to 600—900°C depending upon the glass composition. The mixture is held at the required temperature for from 20 to 120 min. The temperatures used ensure the obtainment of a glass melt possessing a low dynamic viscosity (about 10^3 poise), whereby the glass is free to penetrate into small pores, cracks and other flaws of the diamond surface by capillery action, thus enabling, during subsequent cooling of the mixture to room temperature, a strong glass-to-diamond bond in the solid state. The resultant frit which is essentially a cooled-down mixture, is disintegrated into diamond clusters 2 the majority of which (up to 90 percent) are composed of 2—8 diamond grains dispersed in each portion of the glass.

The thus-obtained clusters 2 are mixed with the bonding material 5, and an abrasive tool is fabricated by a conventional method. The bonding material can be either organic or metallic.

Exemplary glass compositions used in the tool of the invention, to contain the diamond particles, are given in the Table below:

TABLE

Glass No.	Oxide	Wt. %	Oxide	Wt. %	Oxide	Wt. %	Oxide	Wt. %	Oxide	Wt. %
1	SiO_2	65	B_2O_3	10	Na_2O	20	CaO	5	–	–
2	SiO_2	65	B_2O_3	10	Li_2O	20	CaO	5	–	–
3	SiO_2	48	B_2O_3	20	Na_2O	17	BaO	5	–	–
4	SiO_2	60	B_2O_3	15	Na_2O	15	BeO	10	–	–
5	SiO_2	55	B_2O_3	10	Na_2O	20	CaO	5	TiO_2	10
6	SiO_2	50	B_2O_3	15	Na_2O	20	CaO	5	Al_2O_3	10
7	SiO_2	52	B_2O_3	8	Li_2O	21	MgO	7	ZrO_2	12
8	SiO_2	62	B_2O_3	20	Na_2O	8	SrO	5	Cr_2O_3	5
9	SiO_2	50	B_2O_3	15	Na_2O	20	CaO	5	TiO_2	10
10	SiO_2	53	B_2O_3	17	Li_2O	15	CaO	6	Al_2O_3	9

The glass compositions given in the Table incorporate oxides that are not reduced by the diamond at the temperatures used in producing the clusters (from 600 to 900°C), as follows:

$$MeO+C \rightarrow Me+CO,$$

where Me is an oxidized element,
C is the carbon of diamond,
CO is gaseous carbon monoxide.

If the glass incorporates oxides that are liable to interreact with the diamond according to the above reaction at the cluster-producing temperature, the result is that gaseous carbon monoxide is liberated at the position of glass-to-diamond contact, said carbon monoxide adversely affecting the glass-to-diamond bond strength when the cluster is in the solid state. This, in turn, reduces the strength of retention of the diamonds in the cutting layer of the tool, which eventually causes an increased specific diamond consumption. The use of a glass consisting of oxides that are not reduced by the diamond results in a strong diamond-to-glass adhesion.

However, the glass must not only be resistant to reduction by the diamond, for the glass used in the tool of the present invention is also capable of wetting the diamond surface at a temperature in the range from 600 to 900°C. The marginal angle of wetting of the diamond with the glasses of the compositions given in the above Table ranges from 18 to 50°.

The glass No. 5 of the above Table is the most suitable for use in the abrasive tool of this invention, the marginal angle of wetting of the diamond with said glass being 18°.

At present, widespread application is gained by abrasive tools on an organic bond with

metallized diamonds. Given below are the results of comparative trial tests of a grinding wheel with metallized diamonds and a grinding wheel with diamonds aggregated into clusters by the glass No. 5 given in the above Table. Both wheels had an organic bonding material and were tested in machining hard alloy without cooling at a longitudinal feed rate of 2 m/min and a peripheral grinding wheel speed of 16 m/sec. At a cross feed of 0.02 mm per double stroke the wheel with the diamond clusters aggregated by the No. 5 glass showed a specific diamond consumption of 1.60 mg/cm³ and a temperature of 280°C within the zone of contact of the wheel with the surface being machined, while for the wheel with metallized diamonds the specific diamond consumption was equal to 1.55 mg/cm³ and the temperature reached 430°C.

As is evident from the test results, the specific diamond consumption for both types of wheels is practically the same, whereas the temperature within the zone of contact of the grinding wheel with the surface being machined for the wheel with diamonds aggregated into clusters by glass, is much lower with the result that burnt spots and microcracks on the surface machined occur much less frequently and, therefore, a high-quality surface finish is obtained.

The specific diamond consumption is the amount of diamond (in mg) consumed for the removal of 1 cm³ of material being machined.

WHAT WE CLAIM IS:—

1. An abrasive tool whose cutting layer comprises a bonding material throughout which are distributed diamond particles dispersed in glass, the glass comprising SiO_2, B_2O_3, an oxide selected from Na_2O and Li_2O, and an oxide selected from CaO, BaO, BeO, SrO and MgO, and the marginal angle of wetting of the diamond with the glass at a temperature in the range from 600 to 900°C being less than 90°.

2. An abrasive tool as claimed in claim 1, including an oxide selected from TiO_2, Al_2O_3, Cr_2O_3 and ZrO_2.

3. An abrasive tool as claimed in claim 1 or 2, wherein the glass comprises the following components in weight per cent:

SiO_2	48—65
B_2O_3	20—3
Na_2O and/or Li_2O	22—10
an oxide or oxides selected from CaO, BaO, BeO, SrO and MgO	10—4
an oxide or oxides selected from TiO_2, Al_2O_3, Cr_2O_3 and ZrO_2	0—18

4. An abrasive tool as claimed in claim 3, wherein the glass comprises the following components in weight per cent:

SiO_2	55
B_2O_3	10
Na_2O	20
CaO	5
TiO_2	10

5. An abrasive tool as claimed in claim 1, substantially as hereinbefore described.

6. An abrasive tool as claimed in claim 1, substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

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1418730 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

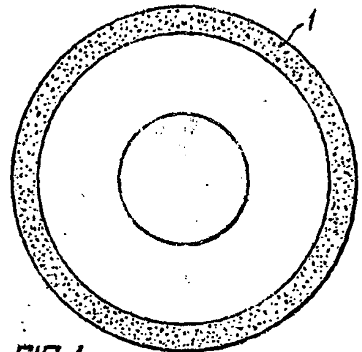

FIG.1

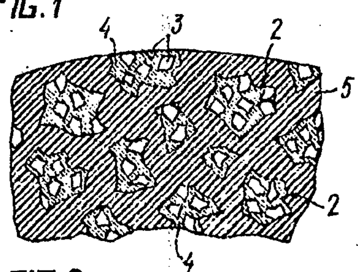

FIG.2